



# Energy Storage Program

ONR Program Code 33

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## At a Glance

### What is it?

■ ONR's current Energy Storage Programs are focused on battery and capacitor science and technology. Research areas are selected to leverage work of other funding agencies in this area such as the Department of Energy and other branches of the Department of Defense and focus on issues more unique to the Navy and Marine Corps.

### How does it work?

■ The unifying goal of the programs is to increase the energy storage density through materials level basic and applied research.

### What will it accomplish?

■ The program will increase the basic understanding of the electrochemical and dielectric properties of materials and identify novel pathways towards increased energy storage densities for battery and capacitor devices.

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The Office of Naval Research's Energy Storage Program is focused on two areas:

### Capacitors

Large pulse power capacitors have been identified as a critical Navy unique area. The majority of the ONR Capacitor Program focuses on high pulse power requirements, since the greatest scientific and technical challenges must be addressed to meet that critical need. ONR's basic research program focuses on storage density at the materials level (the fundamental limitation to energy density at the device level), and dielectric breakdown mechanisms (breakdowns limit the voltage and usable storage density). There is also significant potential for hybrid materials that combine the strengths of polymers and ceramics, if the benign failure feature of polymer dielectrics can be retained; this is currently being explored. ONR's applied research program includes exploitation of the benefits of both the ceramic and polymer in hybrid materials systems, addressing scale-up issues for materials identified in the basic research program, and developing new device geometries and packaging that maximize the energy and power density in practical devices that are amenable to large-scale manufacturing to produce sufficient supply for the large capacitor banks envisioned for electric ship applications.



### Batteries

The ONR Battery Program, an extension of the Electrochemistry Program, builds on a foundation of enabling science for three-dimensional, battery architectures and recent demonstrations of several small laboratory scale 3D devices. Current efforts are focused on addressing key issues in non line-of-sight conformal thin film deposition over tortuous surfaces, effective infiltration of the counter electrode, and cell scaling to enable practical applications.

### Research Challenges and Opportunities

- Scalable approaches to increasing stored energy density in polymer and hybrid material dielectric films with low losses and potential to store 30 J/cc on a materials level
- Approaches for increased understanding of dielectric breakdown in polymer film and composite (polymer/polymer; polymer/ceramic dielectrics, including approaches to achieve graceful failure
- Approaches for overcoming the current limitations in 3-dimensional power source architectures, particularly those that address the impacts of nanoscale separation of electrodes

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